# APPENDIX C
# SEDIMENT/HABITAT TARGET DEVELOPMENT

The following section contains a summary data analysis for base parameter data collected in support of TMDL development in the Lower Blackfoot Planning Area. The analysis includes a basic reach classification and assignment of each assessed stream segment to a reach type population, and a presentation of summary statistics for each reach type. The summary statistics describe the quantitative data associated with each site that have been used to develop TMDL targets for sediment and habitat related impairments.

The development of sediment/habitat target values for the Lower Blackfoot TMDL Planning Area requires the identification of parameters that are closely linked to a cold water fishery or aquatic life beneficial use support. In some cases, the parameters also relate to the contact recreation beneficial use. That is, some streams have been listed as non-supporting or partially supporting of primary contact recreation due in part to problems with substrate or flow conditions, both of which can be assessed using parameters described below. The parameters for which target values have been developed to help determine the sediment/habitat impairment status include the following:

- Percent surface fines in riffles measured by pebble count,
- Percent subsurface fines measured by McNeil Core,
- Pool frequency,
- Residual pool depth,
- Width to depth ratio,
- Percent surface fines in pool tailouts,
- Woody bankline vegetation extent,
- Macroinvertebrate metrics,
- Pool extent,
- Entrenchment Ratio,
- Woody debris aggregate extent, and
- Woody debris aggregate frequency.

These parameters address a broad range of direct habitat measures, channel condition measures, and direct measures of aquatic life.

Ideally, reference values for each of the parameters listed above are measured from reference water bodies where all sediment and habitat conditions are functioning at their potential, given historic land uses and the application of all reasonable land, soil, and water conservation practices. However, there was very little internal reference data identified in the lower Blackfoot planning area. In this data summary, target values are derived from a statistical analysis of the entire dataset for the planning area, as well as from regional data from outside the area.

The base parameter assessment sites are grouped into populations based on Rosgen Level I channel type (Rosgen, 1994). For each channel type, fundamental statistics have been developed for each parameter. These statistics include the maximum, minimum, median, and quartile values

for that specific parameter. The results are then compared to the target values developed for and applied to the Lower Blackfoot Planning Area. A Lower Blackfoot Planning Area target is then presented for each parameter. The departure level of each assessed reach relative to that target is displayed via bar chart.

## Reach Classification

The reach classification is based on field observations and measurements of slope, cross section, and substrate. The potential channel type under minimally impaired conditions may be different than the existing channel type, reflecting some degradation of channel cross section. Where such sites were identified, the assigned population for departure analysis reflects the desired channel type condition. The assignment of a channel segment to population reflects a basic level of classification (Rosgen Level 1; Rosgen, 1994); that is, substrate was not included in the population assignment. As such, the population assignment is based on combined data including measured width to depth ratio, surveyed channel slope, surveyed entrenchment ratio, and field observations regarding site potential. E channel types include an Eb sub-type, to account for channels with low width to depth ratios and relatively steep slopes.

**Table C-1. Summary of reach statistics by channel type.**

| Reach | Avg Width to Depth Ratio | Existing Slope (%) | Avg Entrench-ment Ratio | Average D50 (mm) | Existing Type | Potential Type | Populatio n |
|---|---|---|---|---|---|---|---|
| Day2 | 5.1 | 7.7 | 2.5 | 9 | B4a | B | B |
| Keno3 | 6.5 | 3.4 | 4.1 | 2.0 | E4b | E4b | Eb |
| Keno4 | 4.7 | 4.2 | 2.0 | 6.0 | E4b | E4b | Eb |
| Elk2 | 7.2 | 3.5 | 2.5 | 17.0 | E4b | E4b | Eb |
| Elk3 | 5.8 | 1.6 | 14.7 | 18.5 | E4b | E4b | Eb |
| Elk3 | 10.1 | 1.6 | 4.1 | 19.5 | E4b | E4b | Eb |
| Elk5 | 12.8 | 2.1 | 1.7 | 37.5 | B4 | B4 | B |
| Elk7 | 12.5 | 0.7 | 1.6 | 24.5 | B4c | E | E |
| Elk7 | 14.1 | 0.6 | 1.2 | 15.0 | B4c | E | E |
| Elk8 | 12.1 | No data | 1.5 | 12.0 | B4c | E | E |
| Elk9 | 11.3 | 0.2 | 1.3 | 5.0 | E5 | E | E |
| Elk10 | 9.9 | 0.4 | 4.9 | 3.5 | B4c | E | E |
| Elk10 | 6.4 | 0.1 | 1.5 | 15.0 | B4c | E | E |
| Bel2 | 11.5 | 4.2 | 1.3 | 17.5 | B4 | B4 | B |
| Bel4 | 14.5 | 1.9 | 3.6 | 33.5 | C4 | C4 | C |
| Washoe4 | 9.5 | 2.1 | 7.7 | 37.0 | E3 | E3 | E |
| EAshb3 | 6.4 | 3.1 | 5.2 | 12.5 | E3b | E3b | Eb |
| WAshb3 | 8.0 | 2.5 | 2.4 | 21.0 | E3b | E3b | Eb |
| Cam2 | 17.4 | 1.7 | 2.8 | 15.0 | C2 | E4 | E |
| Cam4 | 10.3 | 1.5 | 2.5 | 4.5 | C4 | E4 | E |
| Cam6 | 10.1 | 0.6 | 1.5 | 27.0 | E4 | E5 | E |
| Union1 | 19.1 | No data | 1.6 | 18.0 | B | B | B |

**Table C-1. Summary of reach statistics by channel type.**

| Reach | Avg Width to Depth Ratio | Existing Slope (%) | Avg Entrench-ment Ratio | Average D50 (mm) | Existing Type | Potential Type | Populatio n |
|---|---|---|---|---|---|---|---|
| Union4 | 5.6 | 3.1 | 4.1 | 21.5 | E4b | E4b | Eb |
| Union5 | 11.9 | 1.6 | 1.6 | 9.5 | B4c | E4b | E |
| Union8 | 9.8 | 0.6 | 1.4 | 16.5 | F4/G4c | E4 | E |
| Union8 | 6.7 | 1.2 | 6.4 | 25.0 | F4 /G4c | E4 | E |
| Union11 | 11.6 | 0.5 | 1.8 | 18.5 | F5 | E5 | E |
| Union12 | 14.4 | 2.4 | 1.4 | 111.0 | B3 | B3 | B |

## Width to Depth Ratio

Width to depth ratio, measured as the ratio of bankfull width to mean bankfull depth at riffle cross sections, is an important measure of overall channel form. The parameter is commonly used as a primary stream classification criteria (Rosgen, 1994) and means of site stratification. Width to depth ratios also can provide some indication of channel function, as alluvial streams that undergo significant changes in hydrology, sediment load, or bank stability will respond morphologically and thereby display altered channel cross sections. Reference data sets for width to depth ratio include the Beaverhead/Deerlodge National Forest dataset (Bengeyfield, BDNF), and internal reference reach data from the Middle Blackfoot/Nevada Creek Planning areas.

Target values for width to depth ratio consist of an optimal range for a given channel type. Although the range expresses a typical minimum value for a given channel type, departures are identified in terms of an exceedence of the maximum value of the range (excessively high width to depth ratios). In some cases, the measured width to depth ratio is lower than the expressed minimum of the range. These cases of low width:depth ratios typically reflect natural erosion resistance of bank materials. As a result, measured width to depth ratios below the minimum value do not indicate impairment with respect to aquatic life or the cold water fishery.

A total of three cross sections were surveyed at each assessment site, and the average of those three values used to describes the assessment reach cross section. A statistical analysis of those values based on channel type indicates that several of the E and B assessment reaches have

relatively high width to depth ratios (**Table C-**,

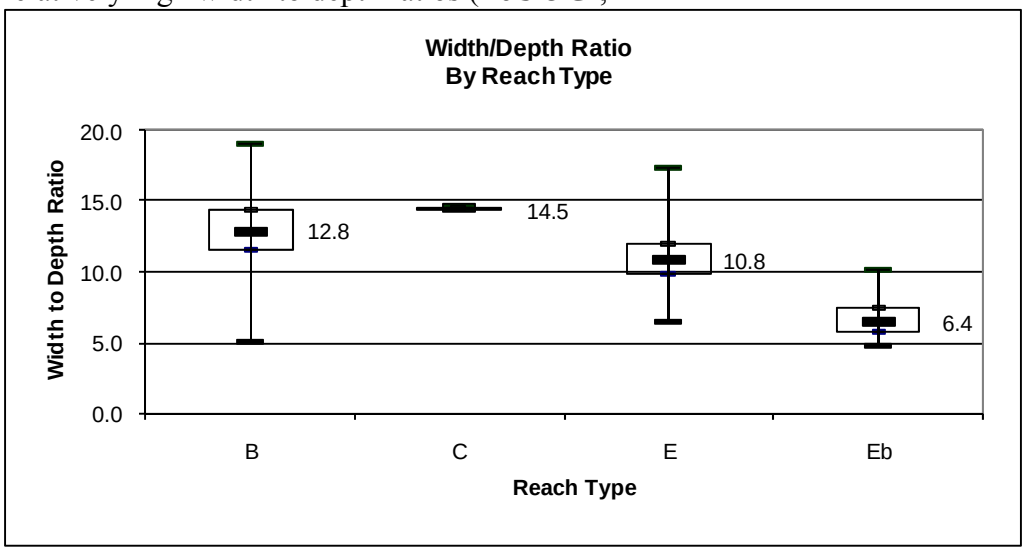


**Figure** C-).

**Table C-2. Lower Blackfoot Planning Area width to depth ratios.**

| Width to Depth Ratio(by Channel Type) | | | | |
|---|---|---|---|---|
| | **B** | **C** | **E** | **Eb** |
| **Q1** | 11.5 | 14.5 | 9.9 | 5.7 |
| **Min** | 5.1 | 14.5 | 6.4 | 4.7 |
| **Median** | 12.8 | 14.5 | 10.8 | 6.4 |
| **Max** | 19.1 | 14.5 | 17.4 | 10.1 |
| **Q3** | 14.4 | 14.5 | 12.0 | 7.4 |
| **N** | 5 | 1 | 14 | 8 |

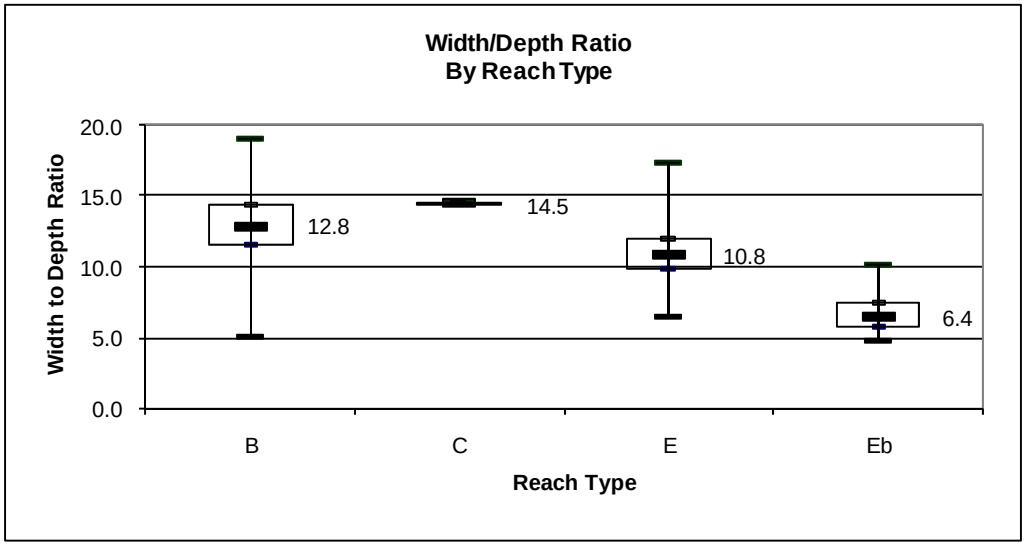


**Figure C-1. Width to depth ratio summarized by channel type, Lower Blackfoot Planning Area; median values are labeled.**

A series of width to depth ratio targets for the Lower Blackfoot Planning Area are compiled in Table C-. For B and E channel types, the targets are based on the classification parameters, and are consistent with those of the Nevada Creek and Middle Blackfoot Planning Areas. The target for C channel types is based on Middle Blackfoot Planning Area data, due to the low number of data points available for the Lower Blackfoot Planning Area.

A comparison of those target values to measured width to depth ratios indicates that upper Union Creek (Un1) has a width to depth ratio that exceeds the B channel target, and that several reaches on Camas Creek and Elk Creek exceed the proposed target for E channel types (**Figure C-1**).

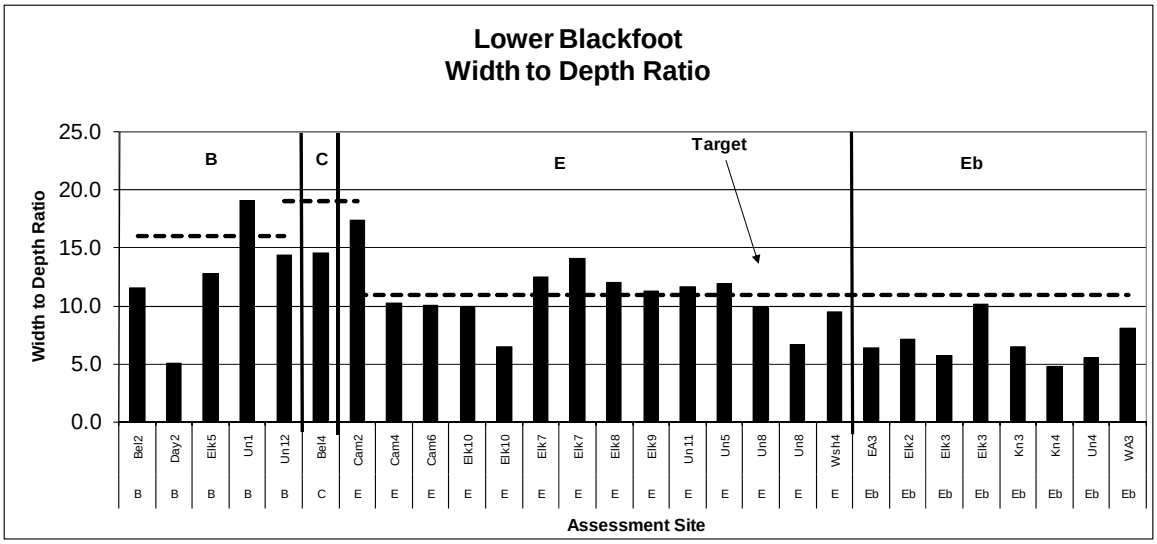


**Figure C-1. Width to depth ratio values for assessment reaches and target values.**

**Table C-3. Lower Blackfoot targets for width to depth ratio.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | 25th Percentile (Q1) | Min | Median | Max | 75th Percentile (Q3) | N | Target | Basis | Target | Basis | | Basis |
| Width to Depth Ratio | Type II | B | 11.5 | 5.1 | 12.8 | 19.1 | 14.4 | 5 | 12 to 16 | Minimum: B type classification | 12 to 16 | Minimum: B type classification | 12 to 16 | Minimum: B type classification |
| | | | | | | | | | | Maximum: Beaverhead/ Deerlodge National Forest (BDNF) Q3; Nevada Creek Q3 | | Maximum: BDNF Q3; Nevada Creek Q3 | | Maximum: BDNF Q3 |
| | | C | 14.5 | 14.5 | 14.5 | 14.5 | 14.5 | 1 | 12 to 19 | Minimum: C type classification | 12 to 20 | Minimum: C type classification | 12 to 19 | Minimum: C type classification |
| | | | | | | | | | | Maximum: Middle Blackfoot median | | Maximum: Nevada Creek median | | Maximum: Middle Blackfoot median |
| | | E | 9.9 | 6.4 | 10.8 | 17.4 | 12.0 | 14 | 6 to 11 | Minimum: E type classification, Middle Blackfoot Q1 | 6 to 11 | Minimum: E type classification, Nevada Creek Q1 | 6 to 11 | Minimum: E type classification |
| | | E b | 5.7 | 4.7 | 6.4 | 10.1 | 7.4 | 8 | | Maximum: E type classification, Middle Blackfoot Q3 | | Maximum: E type classification, Nevada Creek Q3 | | Maximum: E type classification, Middle Blackfoot and Nevada Creek Q3 |

## Entrenchment Ratio

Entrenchment ratio targets are applied to channels for which entrenchment is identified as a negative alteration of the natural channel form. An entrenched condition on open valley stream types reflects a loss in floodplain access. This may occur from channel incision below the active floodplain, or potentially from channel widening and consequent reduction in mean channel depth. Entrenched channels classified as potential E or Eb channel types have an entrenchment target of >2.2, which defines the classification boundary between entrenched and unentrenched streams in the Rosgen classification scheme (Rosgen, 1994).

A summary of measured entrenchment ratios for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-** and **Figure C-2**. Target values are listed in **Table C-1**. When site values are compared with those proposed target values, numerous E type assessment reaches show a high degree of entrenchment (entrenchment value less than the target; **Figure C-3**). This entrenchment of E channel types reflects downcutting and/or channel widening that has reduced floodplain access within the assessment reach.

**Table C-4. Lower Blackfoot Planning Area entrenchment ratios.**

| Entrenchment Ratio | | | | |
|---|---|---|---|---|
| **Statistic** | **B** | **C** | **E** | **Eb** |
| **Q1** | 1.4 | 3.6 | 1.5 | 2.5 |
| **Min** | 1.3 | 3.6 | 1.2 | 2.0 |
| **Median** | 1.6 | 3.6 | 1.6 | 4.0 |
| **Max** | 2.5 | 3.6 | 7.7 | 5.2 |
| **Q3** | 1.7 | 3.6 | 2.7 | 4.1 |
| **N** | 5 | 1 | 14 | 8 |

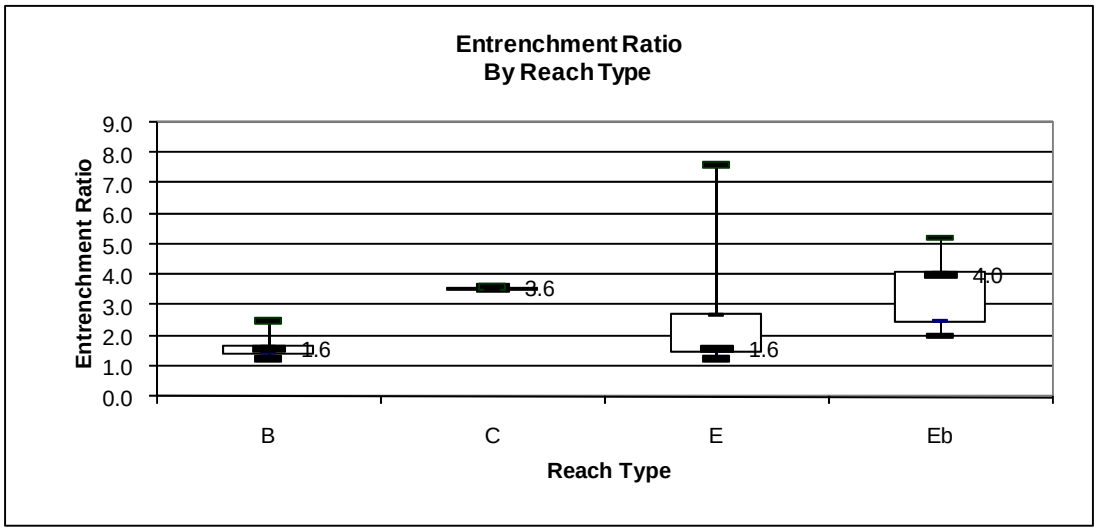


**Figure C-2. Entrenchment ratio summarized by channel type, Lower Blackfoot Planning Area**

**Table C-1. Lower Blackfoot targets for entrenchment ratio.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Entrenchment Ratio | Supp Indicator | B | 1.4 | 1.3 | 1.6 | 2.5 | 1.7 | 5 | N/A | | N/A | | N/A | |
| | | C | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 1 | N/A | >2.2 | N/A | >2.2 | >2.2 | Minimum: C type classification |
| | | E | 1.5 | 1.2 | 1.6 | 7.7 | 2.7 | 14 | N/A | >2.2 | N/A | >2.2 | >2.2 | Minimum: E type classification |
| | | Eb | 2.5 | 2.0 | 4.0 | 5.2 | 4.1 | 8 | N/A | >2.2 | N/A | >2.2 | | |

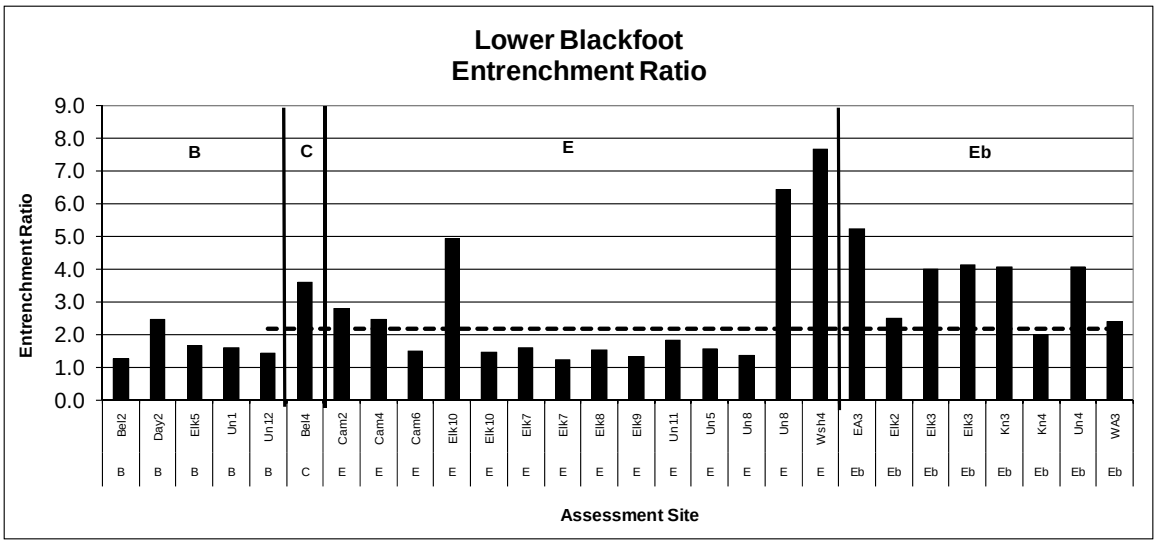


**Figure C-3. Entrenchment ratio values for assessment reaches and target values.**

## Pool Frequency

Pool frequency is an important measure of stream habitat conditions. Pools provide critical habitat for cold-water fish and are linked to the storage, deposition, and sorting of sediment within a channel.

A summary of measured pool frequencies for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-2** and **Figure C-4**. Target values are listed in **Table C-3**. For B and E channel types, the pool frequency values measured in the Lower Blackfoot Planning Area are significantly higher than the targets developed for the Middle Blackfoot and Nevada Creek Planning Areas. Because of these high pool frequencies, the median value measured in the Lower Blackfoot Planning area was selected as an appropriate target. Because there is only one C channel type assessment reach in the Lower Blackfoot Planning Area, the Middle Blackfoot target has been applied for C channel types. When site values are compared with those target values, the assessment reaches show a high variability in pool frequency values for B, E, and Eb channel types (**Figure C-5**).

**Table C-2. Lower Blackfoot Planning Area pool frequency statistics.**

| Pool Frequency | | | | |
|---|---|---|---|---|
| **Statistic** | **B** | **C** | **E** | **Eb** |
| **Q1** | 21.1 | 63.4 | 33.0 | 42.2 |
| **Min** | 10.6 | 63.4 | 21.1 | 26.4 |
| **Median** | 47.5 | 63.4 | 50.2 | 50.2 |
| **Max** | 84.5 | 63.4 | 105.6 | 95.0 |
| **Q3** | 84.5 | 63.4 | 70.0 | 68.6 |
| **N** | 5 | 1 | 14 | 8 |

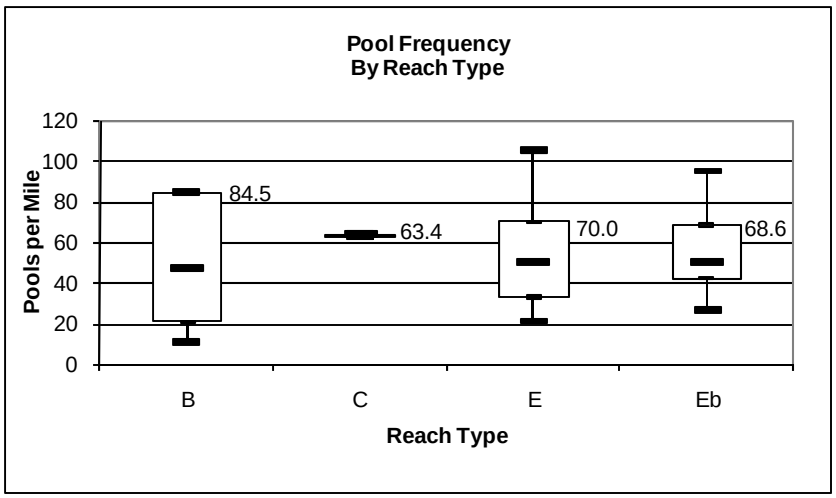


**Figure C-4. Pool frequency summarized by channel type, Lower Blackfoot Planning Area**

| Table C-3. Lower Blackfoot targets for pool frequency. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Parameter** | **Target Level** | **Lower Blackfoot Statistics** | | | | | | | **Middle Blackfoot Targets** | | **Nevada Creek Targets** | | **Lower Blackfoot Targets** | |
| | | **Channel Type** | **Q1** | **Min** | **Median** | **Max** | **Q3** | **N** | **Target** | **Basis** | **Target** | **Basis** | **Target** | **Basis** |
| Pool Frequency (pools per mile) | Target | B | 21 | 11 | 48 | 84 | 84 | 5 | ≥ 20 | Nevada Creek Q3; Reference stream median | ≥ 20 | Nevada Creek Q3; Reference stream median | ≥ 48 | Lower Blackfoot Median |
| | | C | 63 | 63 | 63 | 63 | 63 | 1 | ≥ 55 | Middle Blackfoot Q3 | ≥ 46 | Nevada Creek Q3 | ≥ 55 | Middle Blackfoot Q3 |
| | | E | 33 | 21 | 50 | 106 | 70 | 14 | ≥ 40 | Nevada Creek Q3; Middle Blackfoot reference Q3 | ≥ 40 | Nevada Creek Q3 | ≥ 50 | Lower Blackfoot Median |
| | | Eb | 42 | 26 | 50 | 95 | 69 | 8 | | | | | | |

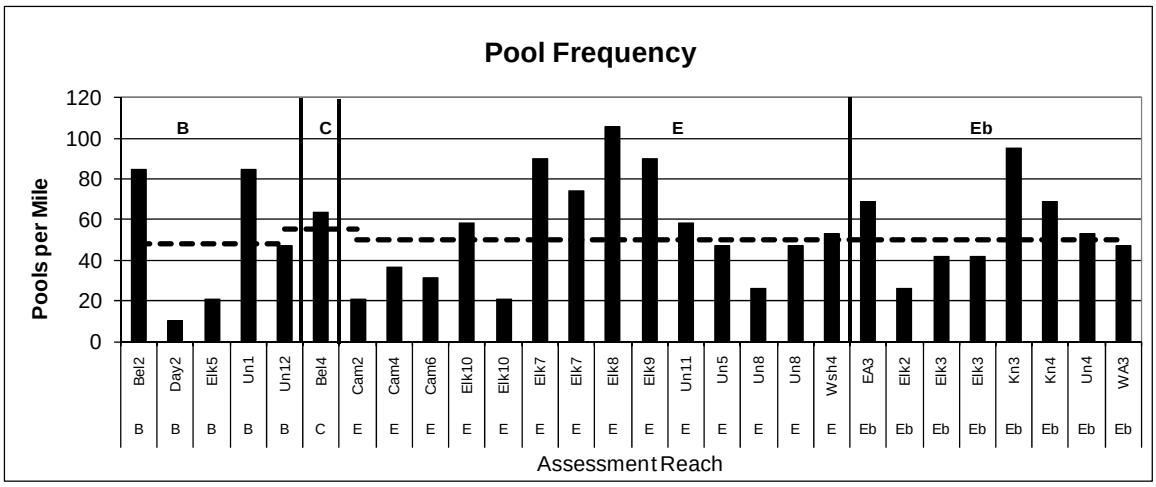


**Figure C-5. Pool frequency values for assessment reaches and target values.**

## Residual Pool Depth

Residual pool depth is a general descriptor of overall pool quality. Pools provide important winter habitat for juvenile fish, as well as refuge from thermal stressors, cover from predators, food, and rearing areas. Pools also provide a general indicator of overall stream complexity.

A summary of residual pool depth statistics for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-4** and **Figure C-6**. Target values are listed in **Table C-5**. The 75th percentile value was selected as a target for B, E, and Eb channel types, and due to a low number of data points, the Middle Blackfoot target was utilized for C channels. A comparison of site values to proposed target values indicate that all reach types have sites in which the target values are not met (**Figure C-8**).

**Table C-4. Lower Blackfoot Planning Area residual pool depth statistics.**

| Residual Pool Depth | | | | |
|---|---|---|---|---|
| **Statistic** | **B** | **C** | **E** | **Eb** |
| **Q1** | 0.58 | 1.12 | 0.66 | 0.59 |
| **Min** | 0.15 | 1.12 | 0.41 | 0.41 |
| **Median** | 0.80 | 1.12 | 0.74 | 0.64 |
| **Max** | 1.15 | 1.12 | 1.51 | 1.22 |
| **Q3** | 1.08 | 1.12 | 0.97 | 0.77 |
| **N** | 5 | 1 | 14 | 8 |

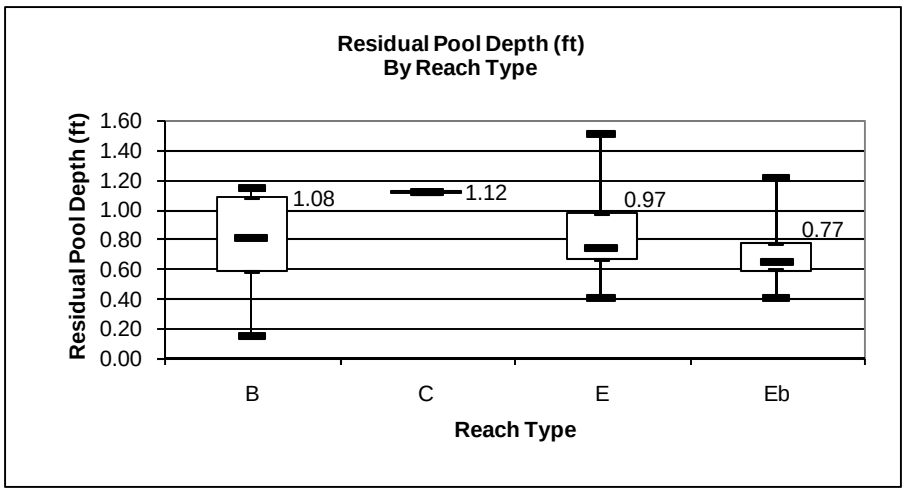


**Figure C-6. Residual pool depth summarized by channel type, Lower Blackfoot Planning Area**.

**Table C-5. Lower Blackfoot targets for residual pool depth.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Residual Pool Depth | Type I | B | 0.58 | 0.15 | 0.8 | 1.15 | 1.08 | 5 | ≥ 0.6 | Nevada Creek Q3 | ≥ 0.6 | Nevada Creek Q3 | ≥ 1.1 | Lower Blackfoot Q3 |
| | | C | 1.12 | 1.12 | 1.12 | 1.12 | 1.12 | 1 | ≥ 2.0 | Nevada Creek Q3; Middle Blackfoot Q3 | ≥ 2.0 | Nevada Creek Q3; Middle Blackfoot Q3 | ≥ 2.0 | Nevada Creek Q3; Middle Blackfoot Q3 |
| | | E | 0.66 | 0.41 | 0.74 | 1.505 | 0.97 | 14 | ≥ 1.5 | Middle Blackfoot reference Q3 | ≥ 1.5 | Nevada Creek Q3 | ≥ 1.0 | Lower Blackfoot Q3 |
| | | Eb | 0.59 | 0.41 | 0.64 | 1.215 | 0.77 | 8 | | | | | ≥ 0.8 | Lower Blackfoot Q3 |

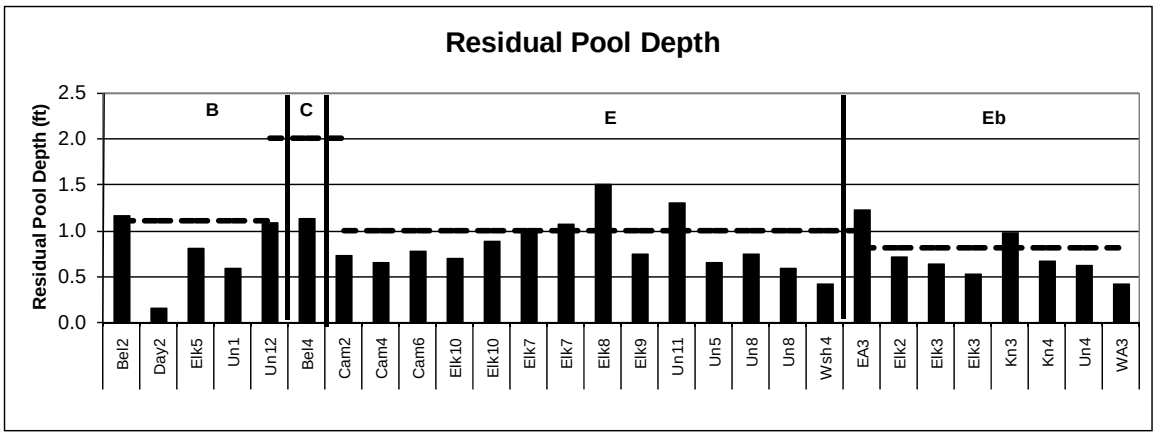


**Figure C-7. Residual pool depth values for assessment reaches and target values.**

## Pool Habitat Extent

The pool extent parameter refers to the percent of total channel length that is comprised of mapped pools units. This measure is linear, and does not reflect pool width or overall volume. However, it is a general indicator of overall channel complexity and extent of pool habitat area.

A summary of pool habitat extent statistics for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-6** and **Figure C-8**. The summary statistics show that Eb channels tend to have a lower extent of pools than E channels; this reflects the high slopes characteristic of the Eb channel type. Proposed target values for pool habitat extent are listed in **Table C-7**. The 75th percentile for assessed sites was used to define the target for B, E, and Eb channel types; the target for C channels is based on Middle Blackfoot Planning Area data due to a low number of C channel assessment sites in the Lower Blackfoot. A comparison of site values to proposed target values indicate that these pool habitat extent targets are not met in most reaches (**Figure C-9**).

**Table C-6. Lower Blackfoot Planning Area pool habitat extent statistics.**

| Pool Extent | | | | |
|---|---|---|---|---|
| **Statistic** | **B** | **C** | **E** | **Eb** |
| **Q1** | 4% | 41% | 10% | 6% |
| **Min** | 2% | 41% | 3% | 5% |
| **Median** | 13% | 41% | 19% | 7% |
| **Max** | 25% | 41% | 48% | 27% |
| **Q3** | 22% | 41% | 35% | 10% |
| **N** | 5 | 1 | 14 | 8 |

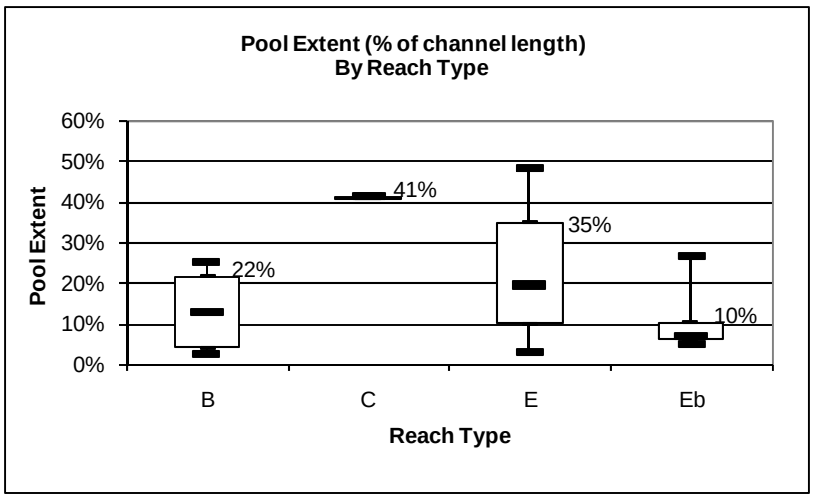


**Figure C-8. Pool habitat extent summarized by channel type, Lower Blackfoot Planning Area**

**Table C-7. Lower Blackfoot targets for pool habitat extent.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Target | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Pool Habitat Extent | Supp. Indicator | B | 4% | 2% | 13% | 25% | 22% | 5 | ≥ 10 | Nevada Creek reference Q3 | ≥ 10 | Nevada Creek reference Q3 | ≥22 | Lower Blackfoot Q3 |
| | | C | 41% | 41% | 41% | 41% | 41% | 1 | ≥ 35 | Nevada Creek Q3; Middle Blackfoot Q3 | ≥ 35 | Nevada Creek Q3; Middle Blackfoot Q3 | ≥ 35 | Nevada Creek Q3; Middle Blackfoot Q3 |
| | | E | 10% | 3% | 19% | 48% | 35% | 14 | ≥ 19 | Middle Blackfoot reference Q3 | ≥29 | Nevada Creek Q3 | ≥ 35 | Lower Blackfoot Q3 |
| | | Eb | 6% | 5% | 7% | 27% | 10% | 8 | | | | | ≥10 | Lower Blackfoot Q3 |

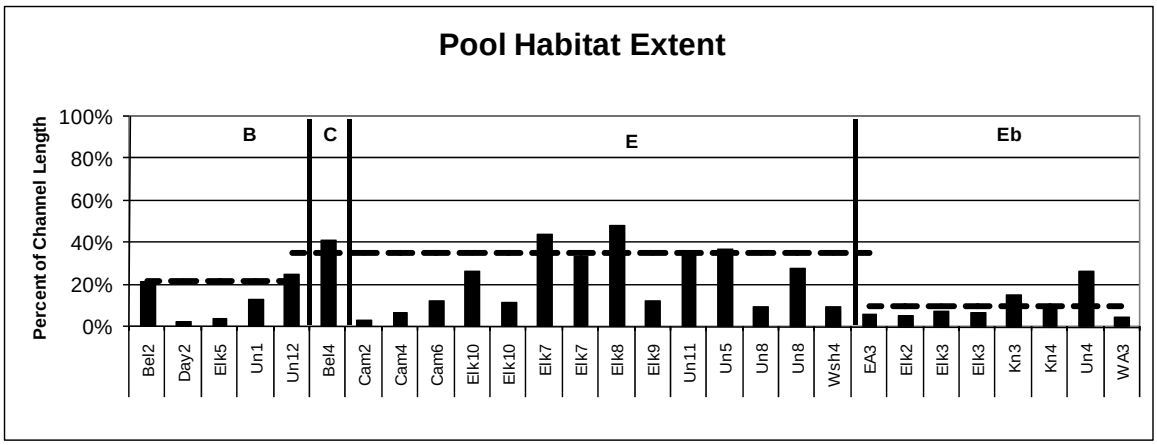


**Figure C-9. Pool habitat extent values for assessment reaches and target values.**

## Woody Debris Aggregate Extent

The percent of total channel length occupied by woody debris aggregates is a general indicator of channel complexity.

A summary of woody debris aggregate extent statistics for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-8** and **Figure C-10**. The assessed B channel on Belmont Creek (Bel2) is in an area of logging activity. As such, B channel types were also evaluated with that site removed from the dataset, since field crews indicated that the conditions were directly associated with proximal land use. Target values for woody debris aggregate extent are listed in **Table C-9**. For B channels, the 75th percentile value for the B channel types was adopted as the target value, with Belmont Creek removed from the dataset. Middle Blackfoot targets were adopted for C, E, and Eb channel types, as these values are slightly higher than the 75th percentile values measured in the Lower Blackfoot Planning Area. A comparison of site values to proposed target values indicate that these preliminary woody debris aggregate extent targets are not met in most reaches (**Figure C-11).**

**Table C-8. Lower Blackfoot Planning Area woody debris aggregate extent statistics (expressed as percent of channel length).**

| Woody Debris Aggregate Extent | | | | | |
|---|---|---|---|---|---|
| **Statistic** | **B** | **B (no Bel4)** | **C** | **E** | **Eb** |
| **25th Percentile** | 3% | 2% | 6% | 2% | 4% |
| **Min** | 0% | 0% | 6% | 0% | 1% |
| **Median** | 9% | 6% | 6% | 4% | 5% |
| **Max** | 75% | 21% | 6% | 19% | 12% |
| **75th Percentile** | 21% | 12% | 6% | 7% | 8% |
| **N** | 5 | 4 | 1 | 14 | 8 |

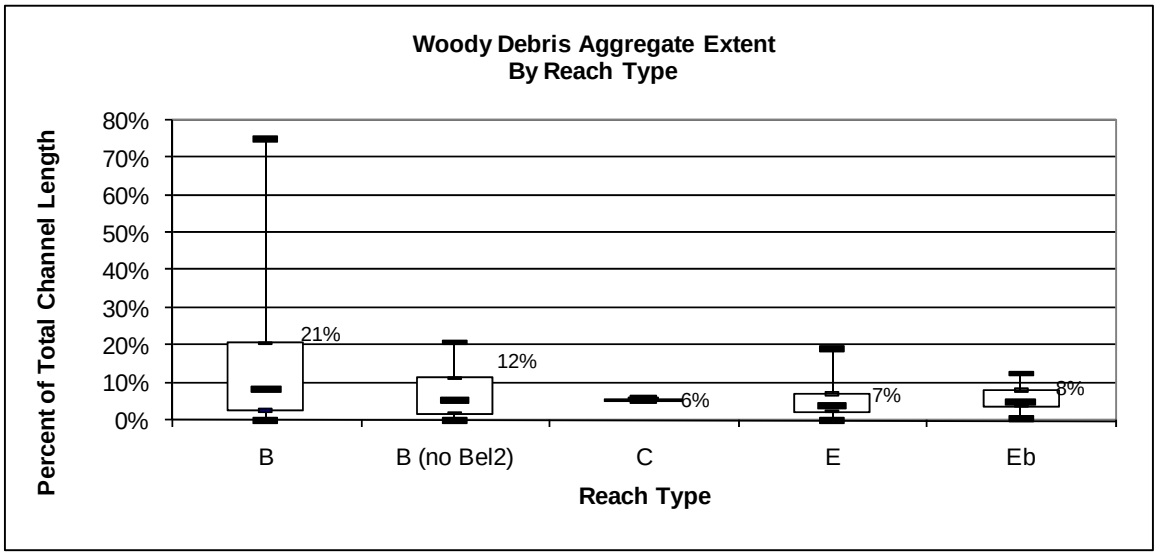


**Figure C-10. Woody debris aggregate extent summarized by channel type, Lower Blackfoot Planning Area.**

**Table C-9. Lower Blackfoot targets for woody debris aggregate extent.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Target | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Woody Debris Aggregate Extent | Supp. Indicator | B | 3% | 0% | 9% | 75% | 21% | 5 | > 3 % | Nevada Creek Q3 | > 3 % | Nevada Creek Q3 | >12% | Lower Blackfoot Q3 (Bel4 excluded) |
| | | B (no Bel4) | 2% | 0% | 6% | 21% | 12% | 4 | | | | | | |
| | | C | 6% | 6% | 6% | 6% | 6% | 1 | > 8% | Middle Blackfoot Q3 | > 7% | Nevada Creek Q3 | > 8% | Middle Blackfoot Q3 |
| | | E | 2% | 0% | 4% | 19% | 7% | 14 | > 12% | Middle Blackfoot reference Q3 | > 12% | Middle Blackfoot reference Q3 | > 12% | Middle Blackfoot reference Q3 |
| | | Eb | 4% | 1% | 5% | 12% | 8% | 8 | | | | | | |

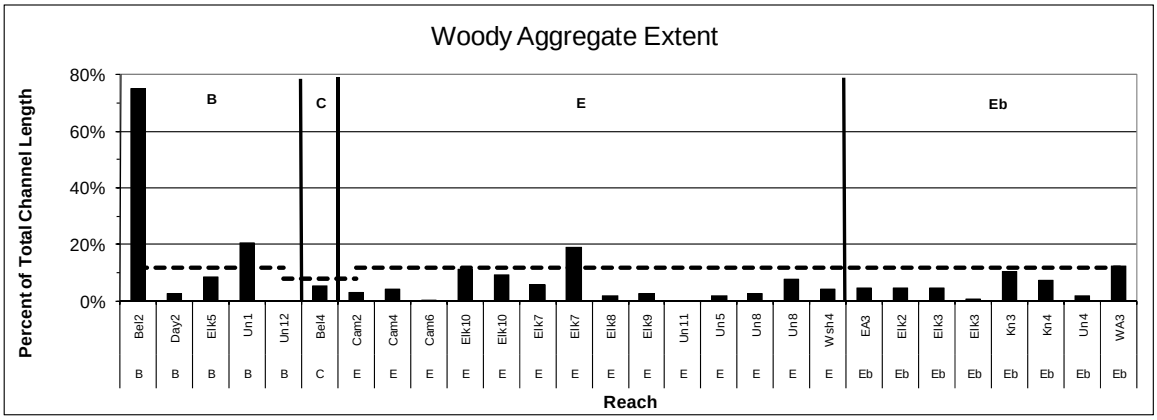


**Figure C-11. Woody debris aggregate extent values for assessment reaches and proposed target values.**

## Woody Debris Aggregate Frequency

The density of woody debris aggregates is a general indicator of channel complexity. A summary of woody debris aggregate frequency (aggregates per mile) statistics for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-10** and **Figure C-12**. The assessed B channel on Belmont Creek (Bel2) is in an area of logging activity. As such, B channel types were also evaluated with that site removed from the dataset due to its high woody debris aggregate extent value that may be directly associated with proximal land use. Target values for woody debris aggregate frequency are listed in **Table C-11**. Targets were not developed for this parameter in the Middle Blackfoot and Nevada Creek TMDL Planning Areas. As a result, for all channel types, the 75th percentile value measured in assessed reaches defines the target. A comparison of site values to proposed target values indicate that these preliminary woody debris aggregate frequency targets are not met in most reaches (**Figure C-13**).

**Table C-10. Lower Blackfoot Planning Area woody debris aggregate frequency statistics.**

| Woody Debris Aggregate Frequency (aggregates per mile) | | | | | |
|---|---|---|---|---|---|
| **Statistic** | **B** | **B (no Bel2)** | **C** | **E** | **Eb** |
| **25th Percentile** | 79 | 59 | 74 | 20 | 24 |
| **Min** | 0 | 0 | 74 | 0 | 11 |
| **Median** | 95 | 87 | 74 | 40 | 50 |
| **Max** | 491 | 222 | 74 | 137 | 148 |
| **75th Percentile** | 222 | 127 | 74 | 55 | 73 |
| **N** | 5 | 4 | 1 | 14 | 8 |

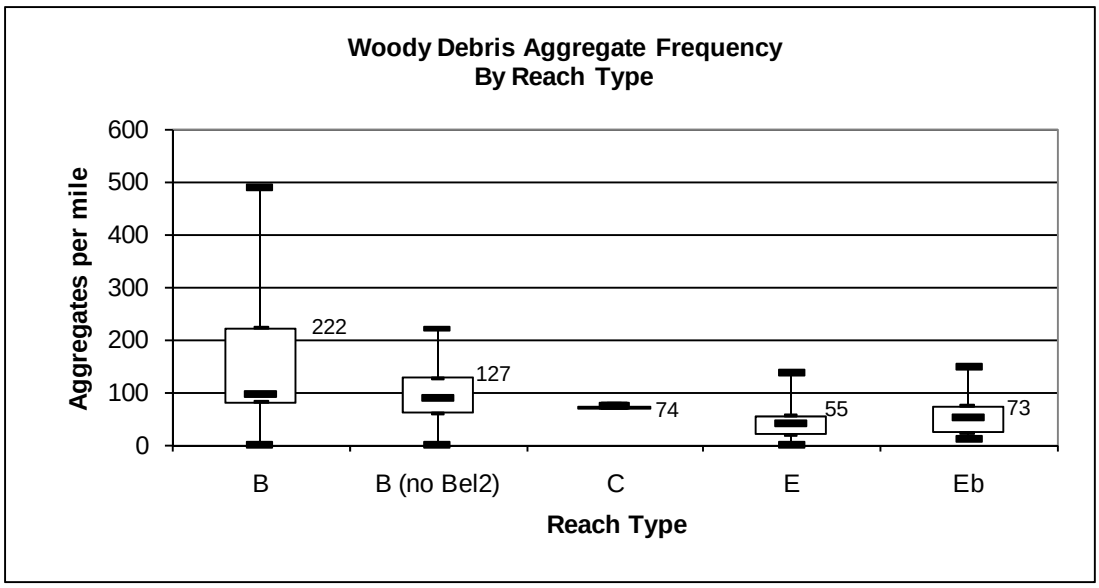


**Figure C-12. Woody debris aggregate frequency summarized by channel type, Lower Blackfoot Planning Area**

**Table C-11. Lower Blackfoot targets for woody debris aggregate frequency (aggregates per mile).**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Target | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Woody Debris Aggregate Frequency | ? | B | 79 | 0 | 95 | 491 | 222 | 5 | N/A | N/A | N/A | N/A | 127 | Lower Blackfoot Q3 (Bel4 excluded) |
| | | B (no Bel4) | 59 | 0 | 87 | 222 | 127 | 4 | | | | | | |
| | | C | 74 | 74 | 74 | 74 | 74 | 1 | N/A | N/A | N/A | N/A | 74 | Lower Blackfoot Q3 |
| | | E | 20 | 0 | 40 | 137 | 55 | 14 | N/A | N/A | N/A | N/A | 55 | Lower Blackfoot Q3 |
| | | Eb | 24 | 11 | 50 | 148 | 73 | 8 | N/A | N/A | N/A | N/A | 73 | Lower Blackfoot Q3 |

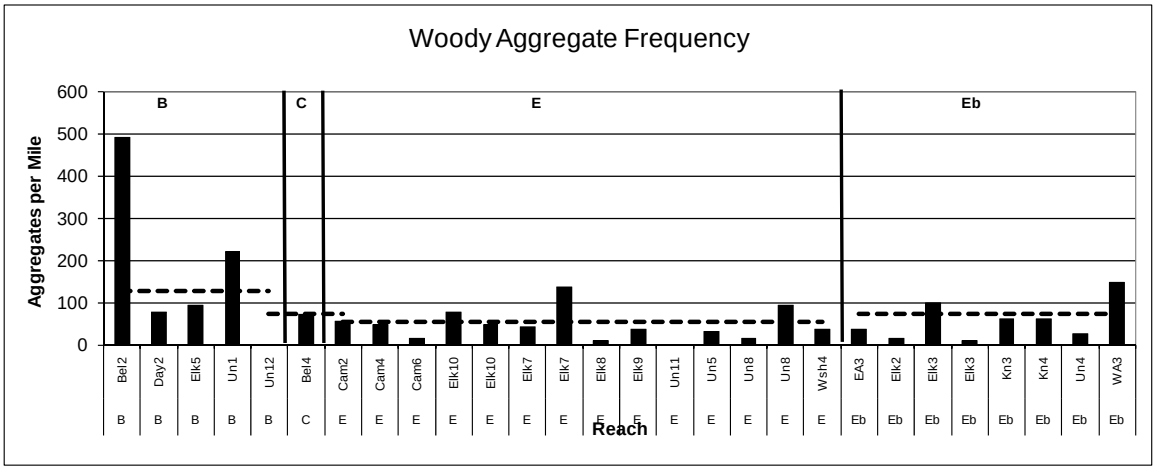


**Figure C-13. Woody debris aggregate frequency values for assessment reaches and target values.**

## Woody Vegetation Extent

The extent of woody vegetation on either channel bank is an important indicator for stream condition related to habitat in terms of cover, shade, and woody debris recruitment. Woody vegetation also adds to bank stability, and can thereby reduce sediment loading to streams. A summary of woody vegetation extent statistics for assessed reaches in the Lower Blackfoot Planning Area is shown in **Table C-12** and **Figure C-14**. Target values for woody vegetation extent are listed in **Table C-13**. For B and C channel types, the Middle Blackfoot targets were adopted, and for E and Eb channel types, the Lower Blackfoot Planning Area 75th percentile value is the target condition. A comparison of site values to proposed target values indicate that the measured extent of woody vegetation is highly variable among E channel types (**Figure C-15**). The results indicate that the listed streams are commonly densely vegetated with woody vegetation.

**Table C-12. Lower Blackfoot Planning Area woody vegetation extent statistics.**

| **Woody Vegetation Extent (% of total channel length)** | | | | |
|---|---|---|---|---|
| **Statistic** | **B** | **C** | **E** | **Eb** |
| **25th Percentile** | 100 | 99 | 16 | 71 |
| **Min** | 64 | 99 | 0 | 33 |
| **Median** | 100 | 99 | 51 | 99 |
| **Max** | 100 | 99 | 100 | 100 |
| **75th Percentile** | 100 | 99 | 67 | 100 |
| **N** | 5 | 1 | 14 | 8 |

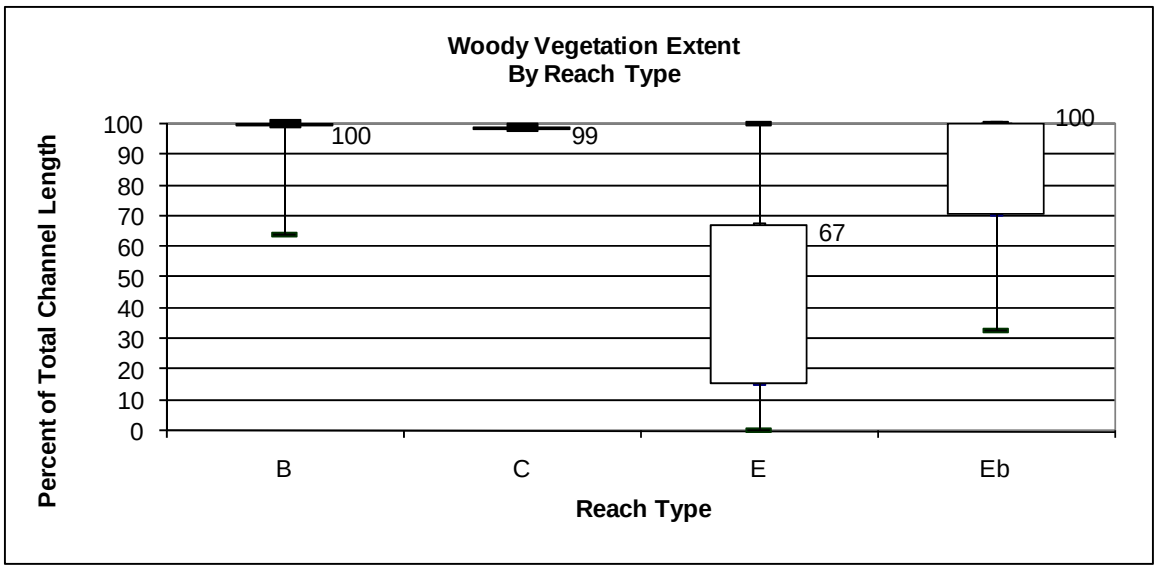


**Figure C-14. Woody vegetation extent statistics summarized by channel type, Lower Blackfoot Planning Area**

**Table C-13. Lower Blackfoot targets for woody vegetation extent.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Target | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Woody Vegetation Extent | Type II | B | 100 | 64 | 100 | 100 | 100 | 5 | > 88 % | Nevada Creek Q3 | > 88 % | Nevada Creek Q3 | >88% | Nevada Creek Q3 |
| | | C | 99 | 99 | 99 | 99 | 99 | 1 | > 84% | Middle Blackfoot Q3 | > 61% | Nevada Creek Q3 | > 84% | Middle Blackfoot Q3 |
| | | E | 16 | 0 | 51 | 100 | 67 | 14 | > 69% | Middle Blackfoot Q3 | > 74% | Nevada Creek Q3 | > 67% | Lower Blackfoot Q3 |
| | | Eb | 71 | 33 | 99 | 100 | 100 | 8 | | | | | 100 | Lower Blackfoot Q3 |

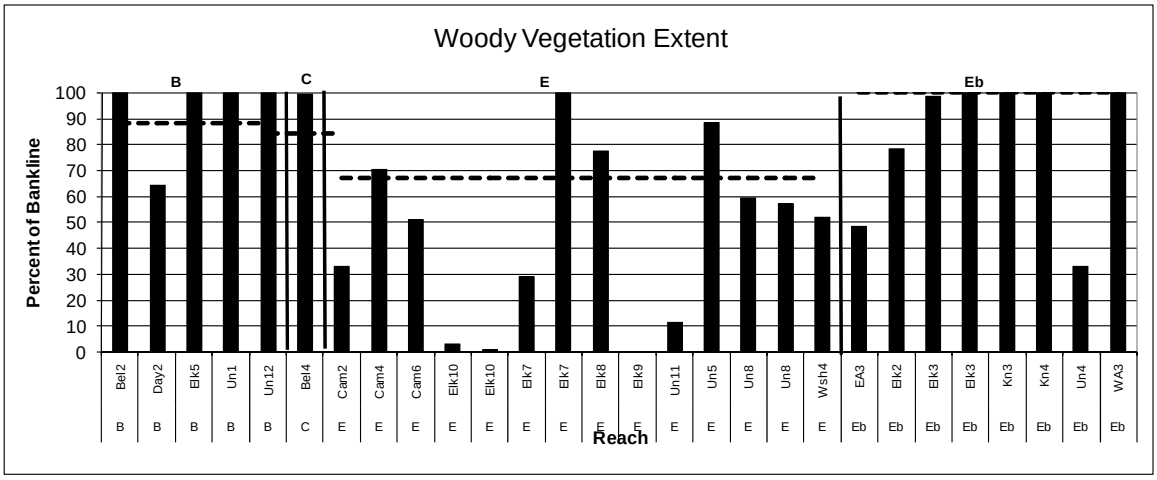


**Figure C-15. Woody vegetation extent values for assessment reaches and target values.**

## Pebble Count <2mm

Target values for percent surface fines provide important criteria used to help define whether excess sediment loading has resulted in a siltation related cause of impairment. A summary of the percent fines fraction less than 2mm in riffles, as measured by pebble counts, is shown in **Table C-14** and **Figure C-16**. Target values for the less than 2mm size fraction in riffles are listed in **Table C-15**. These targets reflect 75th percentile values for all channel types. For B channel types, the Middle Blackfoot/Nevada Creek target is utilized.

Because granitic geology can commonly result in a high production rate of sand-sized sediment, those reaches that have granitic host rock, including upper Elk Creek, Keno Creek, and West Ashby Creek, were analyzed separately from other assessed reaches. These sites are grouped into B(gr) and E(gr) populations. On Elk Creek, only the upper reaches of the listed segment, Elk1 through Elk5 were defined as granitic in nature. A plot of a percent fines trend along Elk Creek shows that fine sediment concentrations decrease in the downstream direction from Elk1 to Elk5, and then increases in the lowermost channel segments (**Figure C-17**). In the lowermost reaches, there is insufficient evidence to indicate that these high fines measurements are directly attributable to headwaters geology. In these lower reaches, low channel gradients, sediment reworking, additional fine sediment inputs, and proximal land uses may be significant controlling factors in sediment concentrations. A comparison of site values to target values indicate that the concentrations of fine sediment <2mm is highly variable among most channel types (**Figure C-18**). For the <2 size fraction, the 75th percentile values are quite close for the Eb and Eb(gr) channel types (33 percent and 35 percent, respectively), indicating that a single target value will likely suffice for these channel types.

**Table C-14. Lower Blackfoot Planning Area pebble count statistics for less than 2mm size fraction in riffles.**

| Statistic | B | B (gr) | C | E | Eb | Eb(gr) |
|---|---|---|---|---|---|---|
| **25th Percentile** | 5.5 | 12.0 | 3.8 | 4.5 | 8.0 | 16.0 |
| **Min** | 1.0 | 11.0 | 2.0 | 0.0 | 2.0 | 7.0 |
| **Median** | 13.0 | 13.0 | 5.5 | 8.0 | 19.5 | 19.0 |
| **Max** | 36.0 | 15.0 | 9.0 | 55.0 | 43.0 | 63.0 |
| **75th Percentile** | 15.0 | 14.0 | 7.3 | 20.0 | 32.5 | 34.5 |
| **N** | 7 | 2 | 2 | 27 | 4 | 11 |

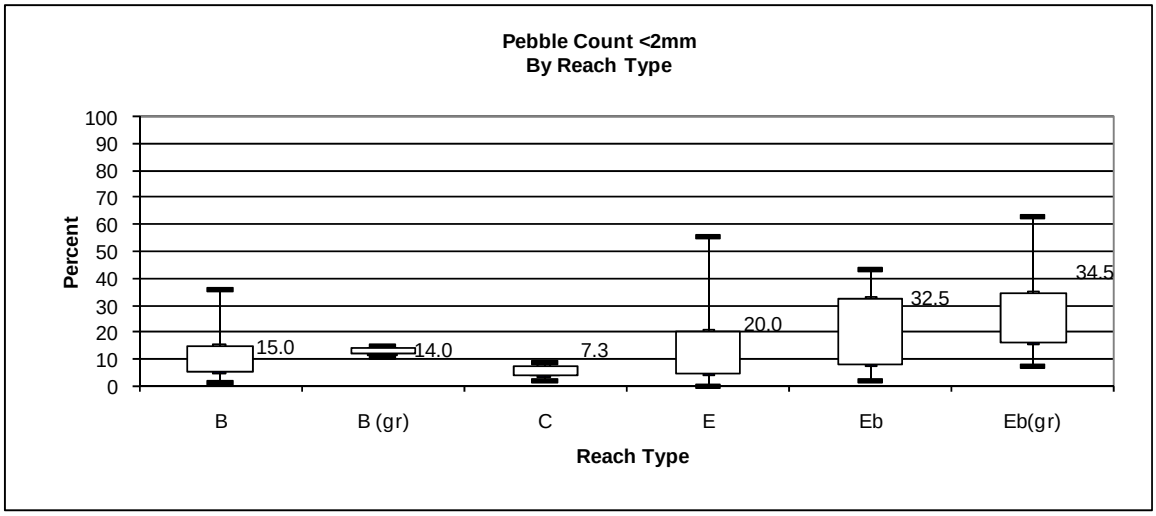


**Figure C-16. Pebble count statistics for less than 2mm size fraction in riffles summarized by channel type, Lower Blackfoot Planning Area**

**Table C-15. Lower Blackfoot targets for pebble count statistics for less than 2mm size fraction in riffles.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Substrate: Percent <2mm in riffles measured by Pebble Count | Type I | B | 6 | 1 | 13 | 36 | 15 | 7 | ≤ 10 | Nevada Creek reference Q3 | ≤ 10 | Nevada Creek Q3 | ≤ 10 | Nevada Creek reference Q3 |
| | | B (gr) | 12 | 11 | 13 | 15 | 14 | 2 | | | | | | |
| | | C | 4 | 2 | 6 | 9 | 7 | 2 | ≤ 11 | Middle Blackfoot Q3 | ≤ 7 | Nevada Creek Q3 | ≤ 7 | Lower Blackfoot Q3, Nevada Creek Q3 |
| | | E | 5 | 0 | 8 | 55 | 20 | 27 | ≤ 34 | Middle Blackfoot reference Q3 | ≤ 20 | Nevada Creek Q3 | ≤ 20 | Lower Blackfoot Q3, Nevada Creek Q3 |
| | | Eb | 8 | 2 | 20 | 43 | 33 | 4 | | | | | ≤ 33 | Lower Blackfoot Q3 |
| | | Eb(gr) | 16 | 7 | 19 | 63 | 35 | 11 | | | | | ≤ 35 | Lower Blackfoot Q3 |

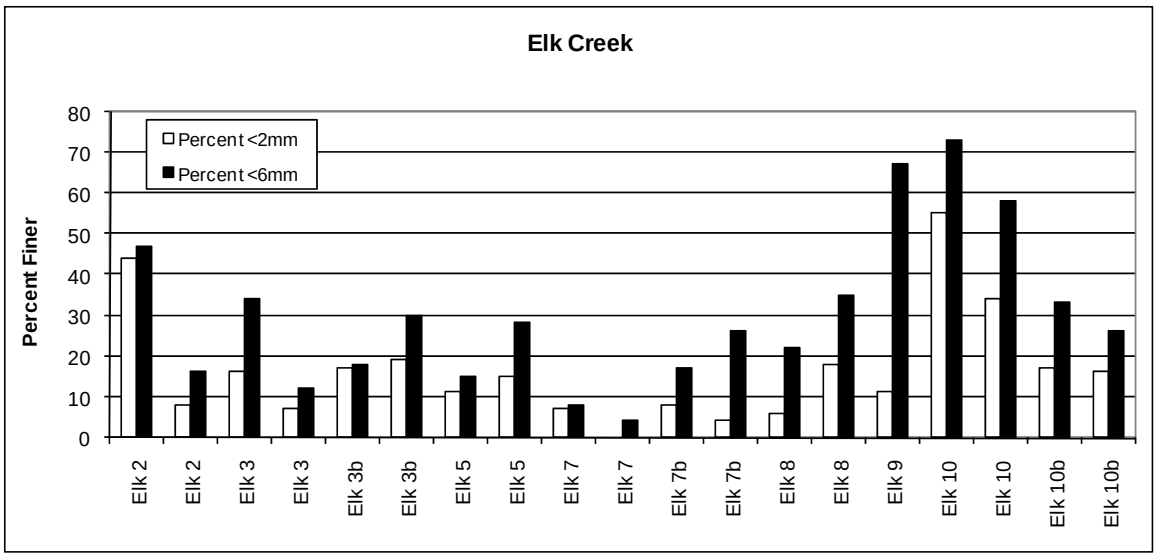


**Figure C-17. Plot of pebble count data showing downstream trend (left to right) in less than 2mm and less than 6mm size fractions, Elk Creek.**

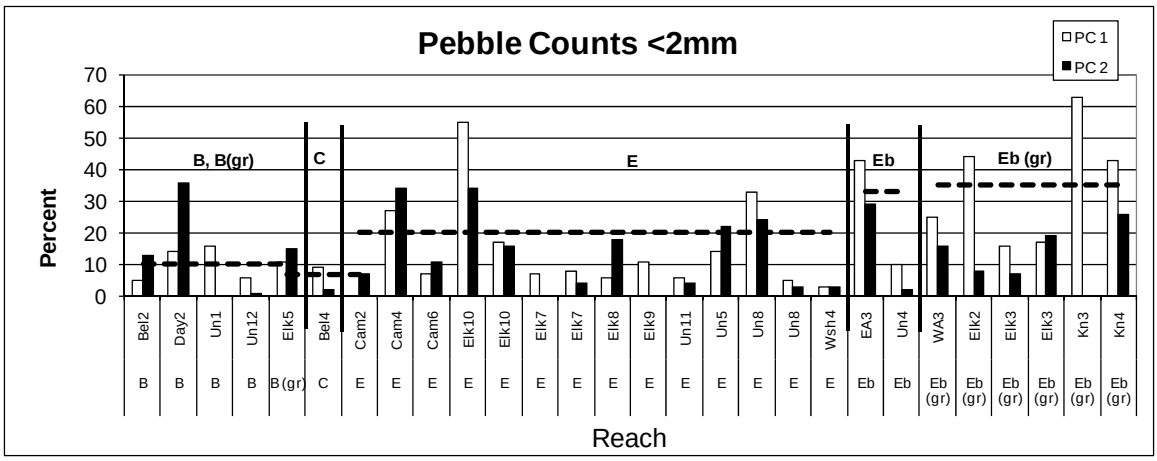


**Figure C-18. Less than 2mm size fraction in riffles values for assessment reaches and target values.**

## Pebble Counts <6mm

Target values for percent surface fines provide important criteria used to help define whether excess sediment loading has resulted in a siltation related cause of impairment. A summary of the percent fines fraction less than 6mm in riffles, as measured by pebble counts, is shown in **Table C-16** and **Figure C-19** Target values for the less than 6mm size fraction in riffles are listed in **Table C-17**. These targets reflect 75th percentile values derived from the Lower Blackfoot Planning Area for E and Eb channel types. For B and C channel types, Beaverhead/Deerlodge National Forest (BDNF) data were utilized to define targets similar to the Middle Blackfoot/Nevada Creek Planning Areas.

Because granitic geology can commonly result in a high production rate of sand-sized sediment, those reaches that have granitic host rock, including upper Elk Creek, Keno Creek, and West

Ashby Creek were analyzed separately from other assessed reaches. These sites are grouped into B(gr) and E(gr) populations. A comparison of site values to proposed target values indicate that the concentrations of fine sediment <6mm is highly variable among most channel types (**Figure C-20**).

**Table C-16. Lower Blackfoot Planning Area pebble count statistics for less than 6mm size fraction in riffles.**

| Statistic | B | B (gr) | C | E | Eb | Eb(gr) |
|---|---|---|---|---|---|---|
| **25th Percentile** | 11.5 | 18.3 | 8.5 | 8.5 | 16.5 | 19.0 |
| **Min** | 1.0 | 15.0 | 6.0 | 3.0 | 9.0 | 12.0 |
| **Median** | 23.0 | 21.5 | 11.0 | 22.0 | 27.0 | 34.0 |
| **Max** | 49.0 | 28.0 | 16.0 | 74.0 | 43.0 | 85.0 |
| **75th Percentile** | 32.5 | 24.8 | 13.5 | 35.0 | 37.0 | 44.5 |
| **N** | 7 | 2 | 2 | 27 | 4 | 11 |

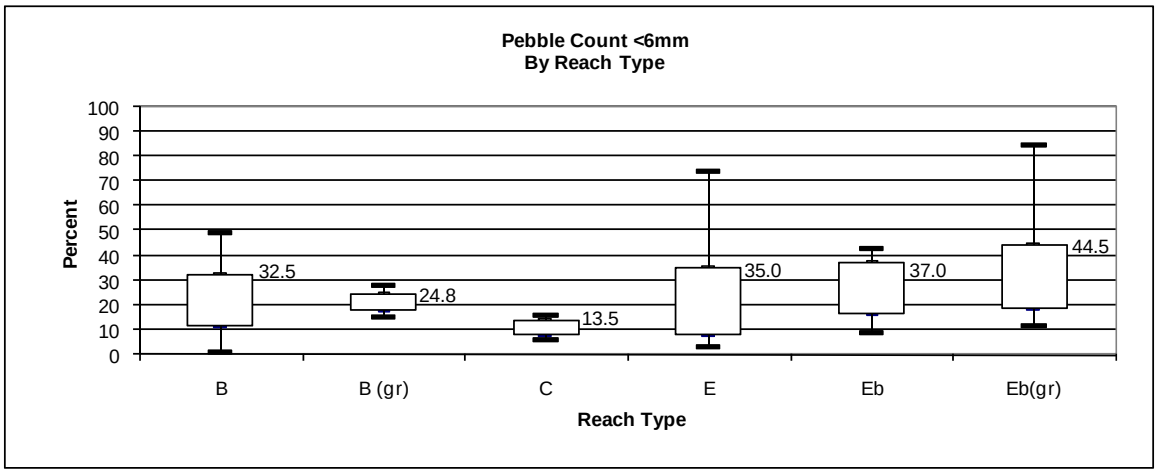


**Figure C-19. Pebble count statistics for less than 6mm size fraction in riffles summarized by channel type, Lower Blackfoot Planning Area**

**Table C-17. Lower Blackfoot targets for pebble count statistics for less than 6mm size fraction in riffles.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Substrate: Percent <2mm in riffles measured by Pebble Count | Type I | B | 12 | 1 | 23 | 49 | 33 | 7 | ≤ 20 | Beaverhead/ Deerlodge National Forest (BDNF) Q3 | ≤ 20 | BDNF Q3 | ≤ 20 | BDNF Q3 |
| | | B (gr) | 18 | 15 | 22 | 28 | 25 | 2 | | | | | | |
| | | C | 9 | 6 | 11 | 16 | 14 | 2 | ≤ 22 | BDNF median (C4 streams) | ≤ 22 | BDNF median | ≤ 22 | BDNF median |
| | | E | 9 | 3 | 22 | 74 | 35 | 27 | ≤ 36 | BDNF Q3 (E4 streams); Middle Blackfoot A ref Q3 | ≤ 36 | BDNF Q3 (E4 streams); Middle Blackfoot ref Q3 | ≤ 36 | Lower Blackfoot Q3 BDNF Q3 |
| | | Eb | 17 | 9 | 27 | 43 | 37 | 4 | | | | | ≤ 37 | Lower Blackfoot Q3 BDNF Q3 |
| | | Eb(gr) | 19 | 12 | 34 | 85 | 45 | 11 | | | | | ≤ 45 | Lower Blackfoot Q3 |

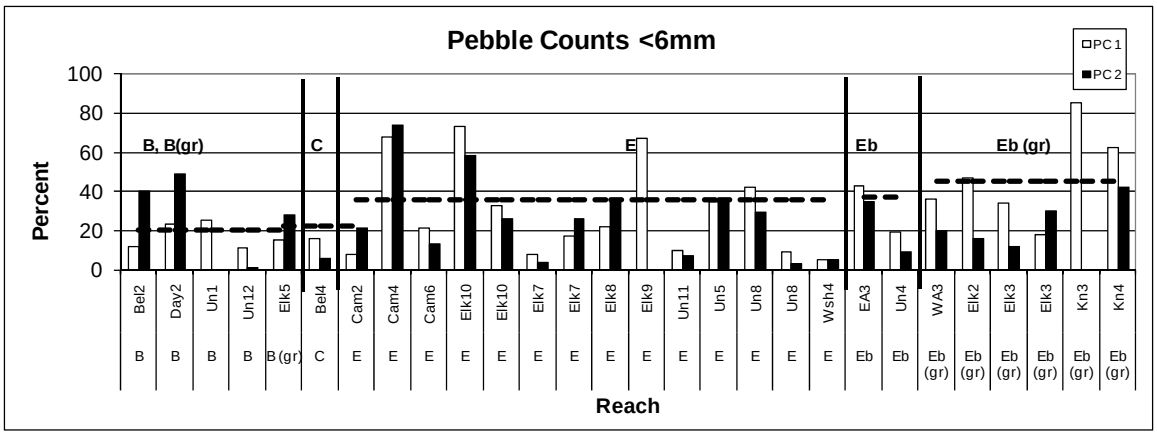


**Figure C-20. Pebble count statistics for less than 6mm size fraction in riffles values for assessment reaches and proposed target values.**

## Surface Fines in Pool Tailouts

Target values developed for surface fines <6mm on the channel bed surface in pool tail environments provide criteria used to help define whether excess sediment loading has resulted in a siltation related cause of impairment. A summary of the percent fines fraction less than 6mm in pool tailouts, as measured by viewing bucket, is shown in **Table C-18** and **Figure C-21.** When the reaches that are located within granitic geology were assessed separately, there was no stratification between that dataset and the non-granitic data set. As such, these separate targets were not developed for granitic and non-granitic source rock for this parameter. Target values for the less than 6mm size fraction in tailouts are listed in **Table C-19**. These targets reflect 75th percentile values for various datasets. A comparison of site values to proposed target values indicate that the concentrations of fine sediment <6mm is highly variable among most channel types, although most assessment reaches meet preliminary targets (**Figure C-23**).

**Table C-18. Lower Blackfoot Planning Area statistics for less than 6mm size fraction in pool tailouts.**

| Pool Tailout Fines | | | | |
|---|---|---|---|---|
| **Statistic** | **B** | **C** | **E** | **Eb** |
| **25th Percentile** | 12.5 | 37.5 | 18.0 | 27.8 |
| **Min** | 5.0 | 37.5 | 3.0 | 6.0 |
| **Median** | 20.0 | 37.5 | 23.3 | 40.5 |
| **Max** | 50.0 | 37.5 | 50.0 | 50.0 |
| **75th Percentile** | 31.3 | 37.5 | 45.5 | 42.0 |
| **N** | 4 | 1 | 14 | 7 |

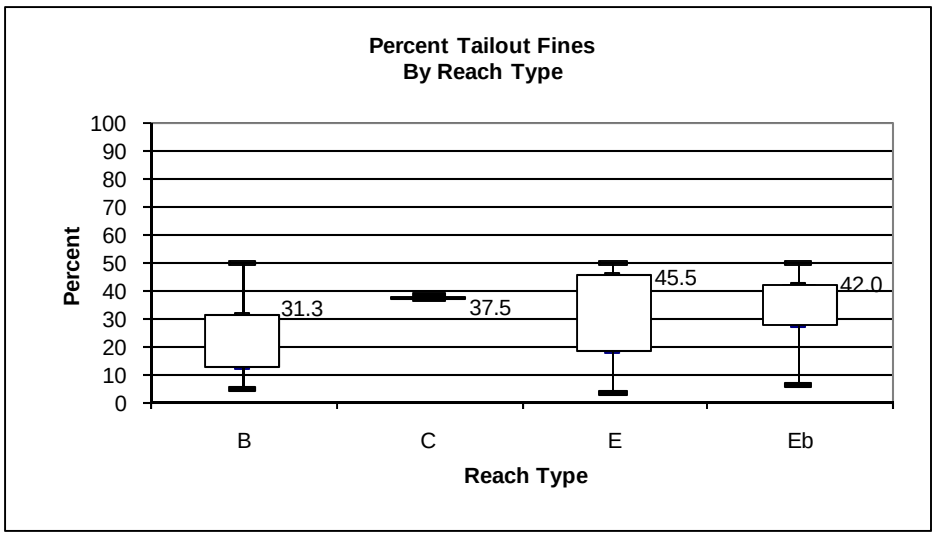


**Figure C-21. Less than 6mm size fraction in pool tailouts summarized by channel type, Lower Blackfoot Planning Area**

**Table C-19. Lower Blackfoot targets for less than 6mm size fraction in pool tailouts.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| Percent Surface Fines < 6 mm, Pool Tailouts, Median | Type II | B | 13 | 5 | 20 | 50 | 31 | 4 | ≤ 17 | Nevada Creek Q3 | ≤ 17 | Nevada Creek Q3 | ≤ 17 | Nevada Creek Q3 |
| | | C | 38 | 38 | 38 | 38 | 38 | 1 | ≤ 20 | Middle Blackfoot Q3 | ≤ 23 | Nevada Creek ref Q3 | ≤ 23 | Nevada Creek ref Q3 |
| | | E | 18 | 3 | 23 | 50 | 46 | 14 | ≤ 48 | Middle Blackfoot ref Q3 | ≤ 82 | Nevada Creek Q3 | ≤ 46 | Lower Blackfoot Q3 |
| | | Eb | 28 | 6 | 41 | 50 | 42 | 7 | | | | | ≤ 42 | Lower Blackfoot Q3 |

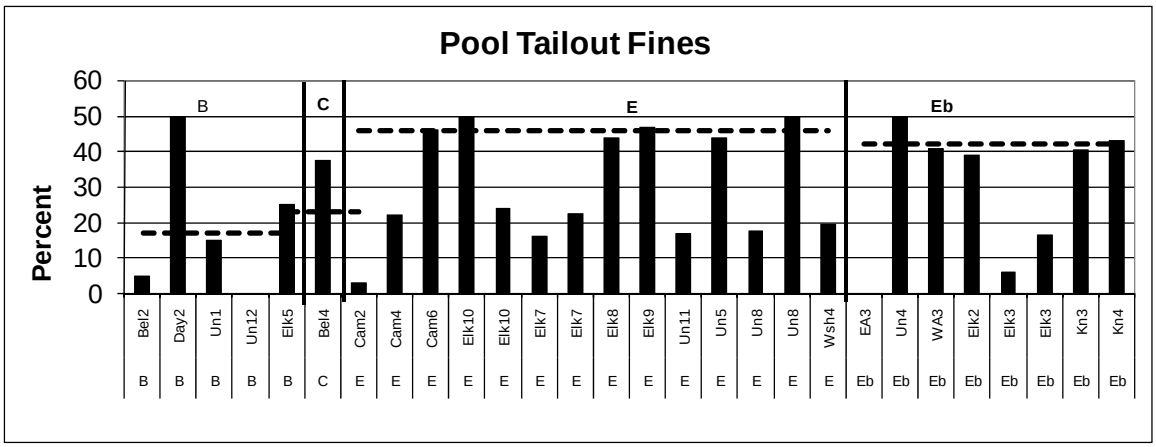


**Figure C-22 Less than 6mm size fraction in pool tailouts values for assessment reaches and target values.**

## McNeil Cores

McNeil Core data provide a quantitative measurement of subsurface fines concentrations in pool tailouts. These measurements are important indicators of excess sediment loading and associated siltation impairment causes. A significant inverse relationship has been observed between the amount of material <6.35mm and bull trout fry emergence success (Weaver and Fraley, 1991). Weaver (1996) stated that streams are threatened as bull trout spawning/rearing streams when the <6.35mm value exceeds 35 percent in any given year. Based on Weaver and Fraley's data (1991), Tepper (2003) predicted an 8.4 percent decrease in egg fry emergence success with an increase in the <6.35mm substrate fraction from 25 percent to 31.7 percent.

A summary of the available McNeil core data is shown in **Table C-20**, **Figure C-23**, and **Figure 24**. The listed stream segments for which data are available include Belmont Creek (Bel4) and Elk Creek (Elk7). Proposed target values for the McNeil Core data are listed in **Table C-21**. Targets were only developed for C channel types, as no data are available to help define appropriate E channel type targets for McNeil Cores. Targets were not developed for the <2mm size fraction because the available data from Elk Creek and Belmont Creek did not identify that size class (**Table C-21**). Targets were developed for the <84mm size fraction for C-type channels (**Table C-21**). The targets adopted are those developed for the Middle Blackfoot and Nevada Creek Planning Areas. A comparison of site values to proposed target values indicate that each of the six samples collected on Belmont Creek exceed the proposed target values for both the <6.35mm and <0.84mm size fractions (**Figure C-25** and **Figure C-26**).

**Table C-20. Lower Blackfoot Planning Area McNeil Core data summary.**

| | Bel 4 (C channel type) | | | Elk 7 (E channel type) | | |
|---|---|---|---|---|---|---|
| **Statistic** | **<0.84mm** | **<0.46mm** | **<6.35mm** | **<0.84mm** | **<0.46mm** | **<6.35mm** |
| **25th Percentile** | 7.7 | 27.4 | 34.9 | 25.1 | 48.3 | 53.7 |
| **Min** | 6.3 | 25.4 | 31.0 | 24.5 | 46.2 | 51.1 |
| **Median** | 8.8 | 34.9 | 43.5 | 29.4 | 51.3 | 57.8 |
| **Max** | 13.2 | 49.3 | 57.5 | 33.6 | 61.0 | 70.3 |
| **75th Percentile** | 10.2 | 44.2 | 53.6 | 33.0 | 55.6 | 60.3 |
| **N** | 6 | 6 | 6 | 6 | 6 | 6 |

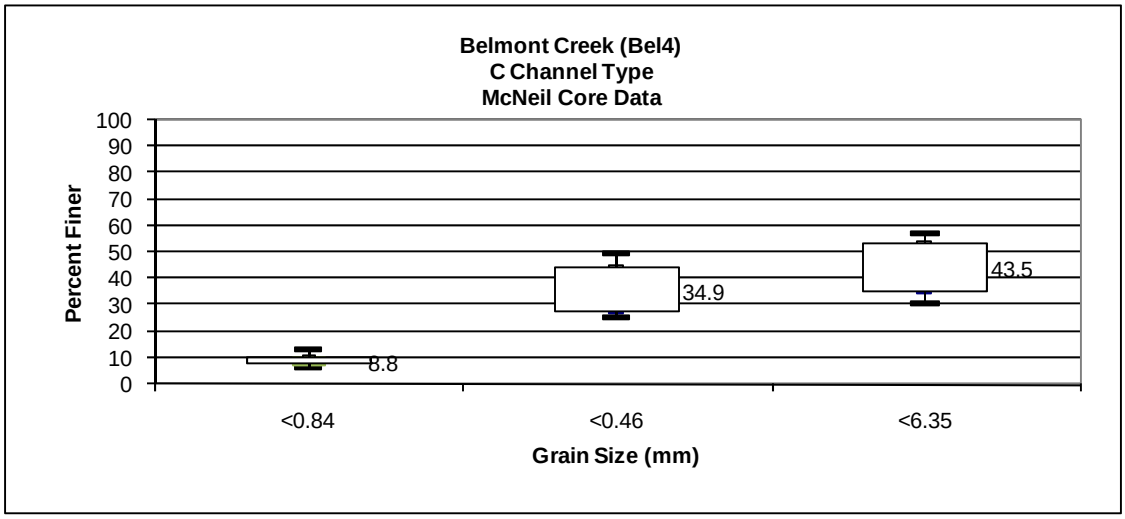


**Figure C-23. McNeil Core data summarized by channel type, Lower Blackfoot Planning Area**

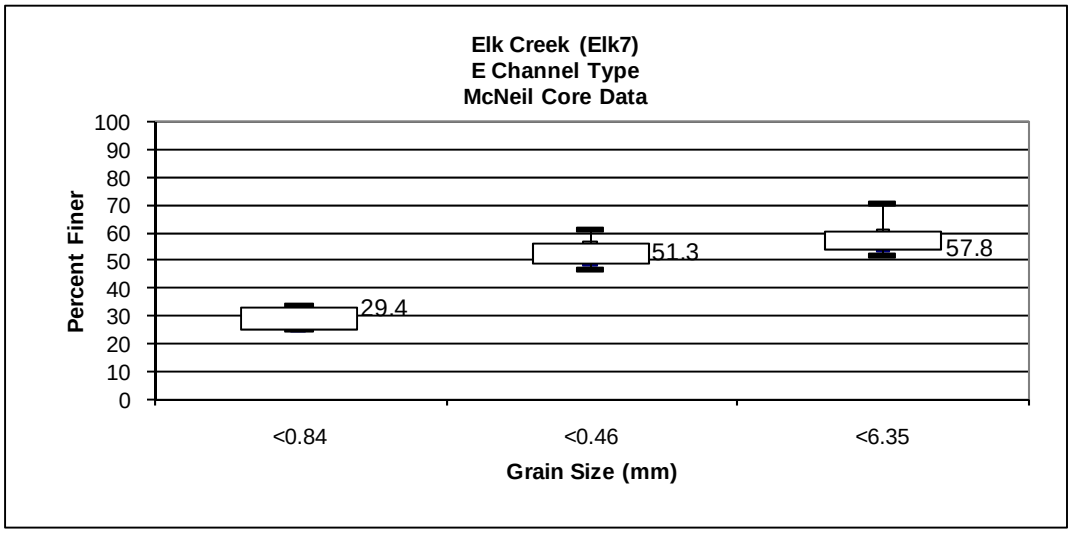


**Figure 24. McNeil Core data summarized by channel type, Lower Blackfoot Planning Area**

**Table C-21. Lower Blackfoot targets for McNeil Core data <6.35mm size fraction.**

| Parameter | Target Level | Lower Blackfoot Statistics | | | | | | | Middle Blackfoot Targets | | Nevada Creek Targets | | Lower Blackfoot Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Channel Type | Q1 | Min | Median | Max | Q3 | N | Target | Basis | Target | Basis | Target | Basis |
| McNeil Cores Measured Percent < 6.35 mm | Type I | C | 35 | 31 | 44 | 58 | 54 | 6 | ≤ 27 | Q1 for all data collected 2003-2006 | ≤ 27 | Q1 for all data collected 2003-2006 | ≤ 27 | Q1 for all data collected 2003-2006 |
| | | E | 54 | 51 | 58 | 70 | 60 | 6 | N/A | N/A | N/A | N/A | N/A | N/A |
| McNeil Cores Measured Percent < 2 mm | Type II | C | N/A | N/A | N/A | N/A | N/A | N/A | ≤ 15 | Q1 for all data collected 2003-2006 | ≤ 15 | Q1 for all data collected 2003-2006 | N/A | No <2mm data summaries |
| | | E | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| McNeil Cores Measured Percent < 0.84 mm | Type II | C | 7.7 | 6.3 | 8.8 | 13.2 | 10.2 | 6 | ≤ 6 | Q1 for all data collected 2003-2006 | ≤ 6 | Q1 for all data collected 2003-2006 | ≤ 6 | Q1 for all data collected 2003-2006 |
| | | E | 25.1 | 24.5 | 29.4 | 33.6 | 33.0 | 6 | N/A | N/A | N/A | N/A | N/A | N/A |

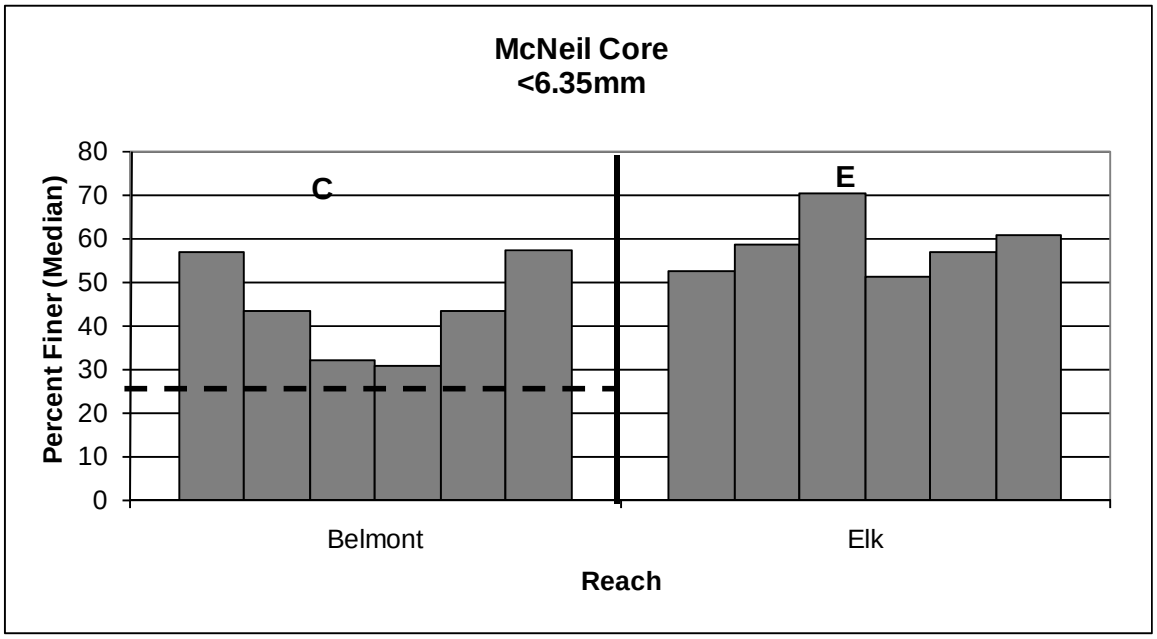


**Figure C-25. McNeil Core data for assessment reaches and proposed target values.**

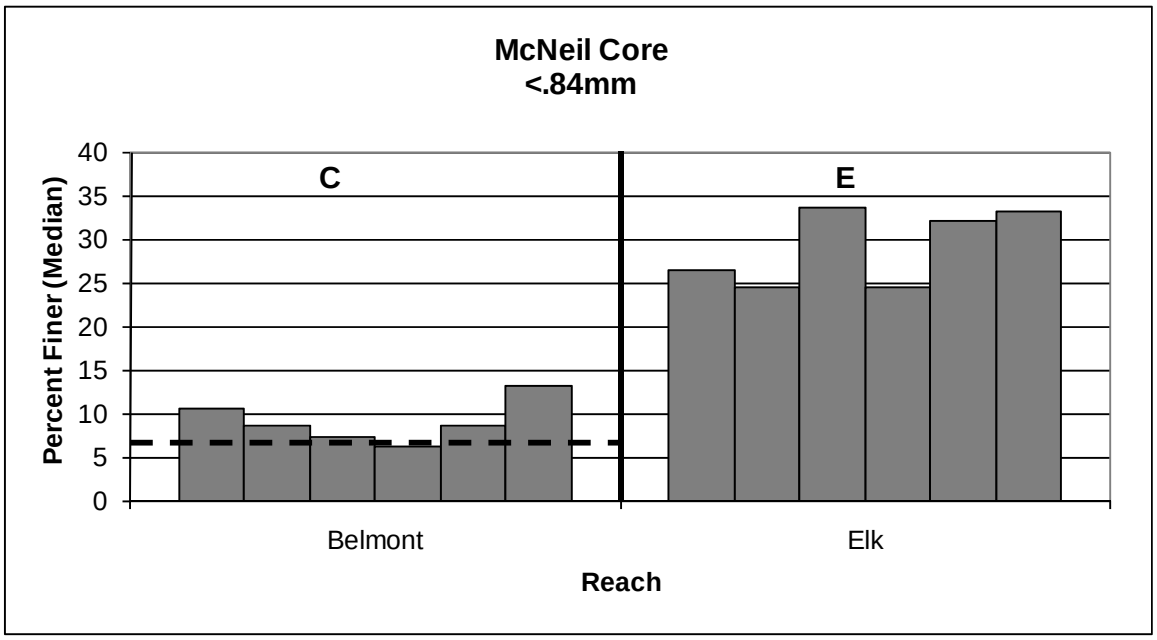


**Figure C-26. McNeil Core data for assessment reaches and proposed target values.**

**References**

Rosgen, D.L., 1994, A classification of natural rivers. Catena: 22, 169-199.